Disaster Preparedness and the Mitigation of Sudden Fire Outbreaks in Public Boarding Secondary Schools in Machakos County, Kenya

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ABSTRACT

Despite being legally mandate to take care of learners under in loco parentis principle, public boarding secondary schools in Kenya continue to suffer catastrophic fire outbreaks. The study examined the structural, operational and psychosocial factors influencing fire disaster preparedness in the county of Machakos, which was also hit by the 2001 Kyanguli fire accident in which 67 students lost their lives. This study adopted cross sectional mixed methods approach based on Maslow's hierarchy of needs theory and Erikson's psychosocial development theory. The questionnaire was returned by 73 principals (62.3% response rate), 207 teachers (60.5% response rate), and 268 students (69.1% overall response rate), in addition to physical audits at all 117 schools. Descriptive statistics and chi-square tests were used to analyse the data. The findings showed that there were significant gaps between policies and practices. 64.2% of students reported having no knowledge of a fire evacuation plan, while 47.9% of principals said they had a completely functional fire evacuation plan. 41.1% of schools had never had a fire drill and 90.3% of the students were not able to use a fire extinguisher. Of the schools, 65.8% of smoke detectors were rated very inadequate, and 43.8% of dormitories had external locks on the night. The most predominant conflict-resolution method was punitive discipline (89.6% of students) and 60.1% of students experienced no professional counselling. The evidence suggests that fire vulnerability continues to be maintained through the lack of operational safety programmes, gaps in safety equipment, non-compliant architecture and a lack of attention given to the psychosocial needs of adolescents. In addition to greater regulatory enforcement, the following activities are in urgent need of being introduced at that cost: door re-fitting, de-grilling, mandatory drills and/or professional counselling services.

Keywords: fire disaster preparedness, boarding schools, Machakos County, Kenya, safety standards, arson, psychosocial theory

INTRODUCTION

In Kenya, public boarding secondary schools are micro-communities with high school densities and where the learners' parents are replaced by the educational administrators through the legal principle of in loco parentis. Statutorily supported by the Children's Act 2001 and the Basic Education Act 2013. However, there has been a recurring tragedy of violent and devastating outbreaks of fire in boarding schools in Kenya that lead to loss of life in the schools. The causes of these emergencies include deliberate arson, neglect of the structures and deliberate failure to enforce the national fire safety policies (Wanyama & Sitati, 2023). They are highly dangerous and were made very clear during the Kyanguli Secondary School fire in Machakos County in 2001 in which 67 pupils died behind locked doors and with windows grilling heavily, the worst East African institutional fire to date (Mulinge & Kituku, 2022).

In response, the Ministry of Education with support from Church World Service released the Safety Standards Manual for Schools in Kenya in April 2008. This manual gives comprehensive architectural, equipment and procedural instructions to avoid fire tragedies (Musyoki & Muthoka, 2023). However, numerous performance audit reports by the Office of the Auditor-General and empirical field studies have consistently indicated that compliance rates are low, to the extent that the challenge is dire (Ondieki & Nyaboga, 2022). Many public

boarding schools are still operating as high-risk environments, leaving learners vulnerable to unnecessary risks (Mutunga & Mulei, 2024).

Machakos County is a telling example of these vulnerabilities. It has a wide range of institutional capacities due to its varied geography that includes peri-urban areas that are quickly becoming urbanised like Mavoko and rural areas that are water-stressed like Yatta and Matungulu sub-counties. Also, the county has a history of the Kyanguli tragedy. There have been recent localised investigations which have reported serious gaps in fire mitigation programmes, training and equipment. For instance, Kitheka (2023) identified that 70.9% of principals in Yatta sub-County had not set up safety sub-committees. The critical shortage of equipment and absence of practical drills were reported by Mutua (2022) in Lower Yatta, and by Mutiso (2023) in Matungulu, where the rate of fire-related injuries was found to be high, attributed to a lack of hands-on training. Even with these contributions, there is a lack of a comprehensive, county-wide study that explores the structural, operational and psychosocial factors.

This study is based on two theories which are the bases of the study. Maslow's (1943) hierarchy of needs states that physiological and safety needs must be satisfied before the person could move on to seeking other higher level goals, such as learning. The provision of a safe environment to meet these basic needs is compromised where a school is overcrowded, dormitories are unsafe for fire, or there are locked exits (Njoroge & Wambui, 2022). At the same time, Erikson's (1968) psychosocial development theory sees adolescence as the period in which identity versus role confusion is the issue at hand. Recent scholarship has pointed to the role of punitive disciplinary practices, autocratic governance and the repression of student voice in bringing about role confusion and putting adolescents at risk of collective rebellion such as arson in Kenyan boarding schools (Kisilu & Mwende, 2023). Therefore, school fires are seldom simply an environmental issue, they are rooted in institutional and psychosocial contexts.

The current study aimed to achieve the following objectives: (1) to establish the structural implementation of fire disaster management programmes; (2) to investigate the frequency and nature of fire safety training; (3) to examine the adequacy and maintenance of firefighting equipment; (4) to evaluate physical infrastructure compliance with safety standards; and (5) to assess the socio-psychological and administrative root causes of arson in public boarding secondary schools in Machakos County.

LITERATURE REVIEW

The 2008 Safety Standards Manual (SSM) continues to be the main regulatory document on school fire safety in Kenya. It summarises its key architectural, procedural, and equipment requirements in use in recent scholarship (Musyoki & Muthoka, 2023; Wanyama & Sitati, 2023).

Table 1 Key Fire Safety Requirements of the Safety Standards Manual for Schools in Kenya (2008)

Domain	Specific Requirement
Dormitory architecture	Doors are not locked from outside at night and are ≥1.5 m wide, and open outward. Window grills have been removed and windows can be opened from the inside with ease. No triple-decked beds, corridors at least 2 m wide, bed spacing at least 1.2 m. Emergency exit is mid-block.
Firefighting equipment	Dry chemical powder extinguishers, CO_2 extinguishers, fire blankets, sand buckets, and hose reels for use in the accessible areas. All high risk buildings: smoke detectors and heat sensors. A dependable water supply, adequate water pressure, on site.
Emergency procedures	Fire Emergency Evacuation Plan (FEEP) written, practised and displayed in all buildings. Three fire drills with fire drills records each term. Separate fire alarm system from bells.
Administrative structures	Active School Safety Subcommittee and appointed Safety Teacher. Frequent inspections and maintenance logs of equipment. Special provisions for learners with disabilities are provided.

Note. This was adapted from Ministry of Education (2008) as summarized by Musyoki & Muthoka (2023) and Wanyama & Sitati (2023).

A comprehensive framework exists, but national-level surveys indicate that there is continued non-compliance. Ondieki and Nyaboga (2022) found that in their national sample of secondary schools, only 34% had a written FEEP, and 72% of the students had never participated in a fire drill. The Auditor-General's performance audits also showed that fire safety preparedness in Secondary schools continued to be poor, as the majority of the schools did not have working fire alarms and extinguishers (Mutunga & Mulei, 2024). More than 60% of schools in Machakos County had not set up the required safety sub-committees (Muisyo, 2024).

The size of the equipment is also problematic. Kamau and Wanjiru (2023) conducted a survey of 50 schools in Machakos, and found that basic extinguishers were found in most schools, while smoke detectors were nearly absent. In arid and semi-arid areas of the county, water pressure was often inadequate to power hose reels even in the areas with boreholes, Wambua and Muthama said. The physical infrastructure results are more disturbing. Ochieng and Nyamai (2022) reported that 40% of the dormitories still had external locks despite the SSM. Mulinge and Kituku (2022) have reported that in many schools' window grilles were in place, which prevents secondary escape routes.

There has also been growing interest in the psychosocial causes of school fires. Njoroge and Wambui (2022) used Eriksonian theory to examine 15 cases of arson to arrive at the following findings – punitive school culture, peer marginalisation and disempowerment of avenues of legitimate grievances were strong predictors of collective violence. Kisilu and Mwende (2023) have shown that there is high correlation between teachers' choice to use abusive language and students self-reported powerlessness and role confusion. Gachau and Njeri (2022) concluded that not all secondary schools had trained a counsellor, with 28% of secondary schools having a trained counsellor, implying that most of the learners in the secondary schools are not having access to professional psychological support. Overall, these studies have indicated that fire hazard is as much a social issue as it is a physical issue.

This study builds on the literature because it combines architectural audits with multi-respondent perceptual information and psychosocial indicators in a county-wide study to provide an overall diagnostic of the implementation failure.

METHODOLOGY

Study Design and Setting

A cross-sectional, mixed methods survey design was used. The study was performed in Machakos County of Kenya, which has eight sub-counties. The county is divided into a peri-urban and a water-stressed ASAL with different institutional settings.

Population and Sampling

All the 165 public boarding secondary schools in Machakos County were the target population. The sample size was calculated with Yamane's (1973) finite population formula:

$$n = \frac{N}{1 + N(e)^2}$$

where N=165 and e=0.05 (margin of error). This resulted in 117 schools. Stratified random sampling was used to get proportional representation of sub-counties. The target groups within each selected school were the principal, two teachers randomly selected via stratification by class list from the class lists of Forms 1 to 4 and three boarding students (one each as outlined above). Questionnaires were returned by 73 principals (62.4%), 207 teachers (63.3%), and 268 students (76.8%), giving an overall response rate of 69.1% (548 out of 793 distributed). The response rate to the questionnaires ranged between 10% and 60%, but baseline verification

through physical audits of the facilities was successfully implemented in all 117 sampled schools. Table 2 shows summary information about the respondents.

Table 2 Demographic Characteristics of Survey Respondents

Variable	Principals (n=73)	Teachers (n=207)	Students (n=268)
Gender			
Male	71.2%	62.3%	64.2%
Female	28.8%	37.7%	35.8%
Length of service/stay			
0–5 years	0.0%	27.1%	34.7%
6–10 years	31.5%	42.5%	65.3%
Above 10 years	68.5%	30.4%	0.0%

Instruments

Three structured questionnaires (Principals, Teachers and Students) were designed using SSM indicators. The content validity and reliability (Cronbach's alpha: principals = .84; teachers = .79; students = .82) were established in a pilot study with five schools that were not included in the final sample. All 117 schools were observed using a standardised physical audit checklist on dormitory door swing, window grilles, emergency exits and locking mechanisms.

Data Collection and Analysis

The trained research assistants collected data for four months. The data were analysed with descriptive statistics and chi-square tests of independence for SPSS version 27. Observations were made using the physical audit method and principals' self-reports were compared. All ethical clearance was obtained from the appropriate institutional review board and informed and parental consent obtained for all participants.

Results

Structural Implementation of Fire Disaster Management Programmes

A Fire Emergency Evacuation Plan (FEEP) is one of the essential SSM requirements. Table 3 shows that there is a significant difference in perception. Only 18.4% of teachers and 26.1% of students felt that their FEEP was fully operational while 47.9% of principals agreed. Most importantly, 64.2% of students had no idea of an evacuation plan, whereas 1.4% of principals did. There was a significant association between respondent group and perceived status of the plan, $\chi 2$ (8, N = 548) = 258.3, $p < .001$, confirmed by a chi-square test.

Table 3 Perceptions of Fire Evacuation Plan Status Across Respondent Groups

Status	Principals (n=73)	Teachers (n=207)	Students (n=268)
Exists and fully operational	47.9%	18.4%	26.1%
Exists but not used practically	38.4%	14.5%	8.2%
Respondent unaware of plan	1.4%	22.7%	64.2%
No plan, but intends to draft	8.2%	31.9%	1.1%
No plan, no future plans	4.1%	12.6%	0.4%

Note. $\chi^2(8, N = 548) = 258.3, p < .001$.

Furthermore, 80.8% of principals and 95.7% of teachers indicated that their school did not have special arrangements for students with disabilities to evacuate. As for fire alarm systems, 75.3% of principals, 74.9% of teachers, and 79.5% of students said that the ordinary manual bell is used rather than a fire alarm.

While 72.6% of principals said their school has a School Safety Subcommittee, only 38.0% of schools were found to have meeting minutes or inspection logs (physical compliance).

Fire Safety Training and Human Capacity

Table 4 presents the data on frequency of training. The percentages of principals and teachers who reported that fire safety training never had taken place were 41.1% and 45.9% respectively, while 17.2% of students reported the same. This is probably because students may think that the ad hoc assembly is a regular training. There was a significant relationship between training frequency and respondent group $\chi^2(6, N = 548) = 113.7, p < .001$.

Table 4 Frequency of Fire Safety Training as Reported by Respondents

Frequency	Principals (n=73)	Teachers (n=207)	Students (n=268)
Never	41.1%	45.9%	17.2%
Once per term	16.4%	1.0%	1.5%
Twice per year	30.1%	34.3%	67.2%
Once per year	12.3%	18.8%	14.2%

Note. $\chi^2(6, N = 548) = 113.7, p < .001$.

The ones to suffer are the students, and the effect of little or no actual teaching is evident in Table 5. 90.3% of the students and 29.0% of the teachers reported that they could not use a standard extinguisher. The chi-square test confirmed a highly significant group difference, $\chi^2(2, N = 548) = 332.5, p < .001$.

Table 5 Self-Reported Ability to Operate a Fire Extinguisher

Ability	Principals	Teachers	Students
Able	86.3%	71.0%	9.7%
Unable	13.7%	29.0%	90.3%

Note. $\chi^2(2, N = 548) = 332.5, p < .001$.

Training gaps have been noted among specialized personnel. According to reports from principals, just 26.0% of security guards, 23.3% of teachers, and 32.9% of students have ever received formal training in fire safety. On a brighter note, kitchen staff (63.0%) and laboratory technicians (65.8%) performed better, although their training was mostly theoretical.

Adequacy and Maintenance of Firefighting Equipment

principals' assessments are summarized in Table 6. While over 70% of principals rated pressurized extinguishers and sand buckets as adequate or very adequate, there's a significant shortfall in critical early-detection and high-capacity systems. A staggering 65.8% of principals found smoke and heat detectors to be very inadequate, and 75.3% rated fire hydrants similarly. Alarmingly, only 2.7% considered the on-site water supply to be very adequate.

Table 6 *Principals' Assessment of Firefighting Equipment Adequacy (n=73)*

Equipment	Very adequate	Adequate	Inadequate	Very inadequate
Pressurised extinguishers	19.2%	61.6%	15.1%	4.1%
Sand buckets	19.2%	54.8%	19.2%	6.8%
Fire alarms/sirens	19.2%	53.4%	17.8%	9.6%
Fire hydrants	2.7%	9.6%	12.3%	75.3%
Smoke/heat detectors	1.4%	9.6%	23.3%	65.8%

Reliable on-site water supply	2.7%	75.3%	12.3%	9.6%

The functionality of the equipment was also a worry. Sixty-two.8% of teachers and 96.6% of students indicated that there was no regular internal inspection, compared to 87.7% of principals. This difference indicates that if inspections are carried out, then they are not made known to the broader school community.

Physical Infrastructure Compliance

Table 7 shows that there were very significant discrepancies between principals' reported compliance and what was actually observed during physical visits of all 117 schools. 58.1% of buildings had exit doors open out, while 83.6% of principals said they did. 95.9% of principals denied the presence of window grilles, but 26.5% of dormitories were seen with window grilles. Most importantly, 43.8% of dormitories continued to be locked with external padlocks or chains at night, which is against the SSM.

Table 7 Comparison of Claimed and Observed Compliance with Physical Safety Standards

Standard	Principals' claimed compliance (n=73)	Observed compliance (N=117 schools)
Exit doors swing outwards	83.6%	58.1%
Window grilles removed	95.9%	73.5%
Emergency exits available and clear	90.4%	41.0%
Dormitories never locked from outside	56.2%	43.8%

Exposed wiring and overloaded circuits were detected in 68.0% of the buildings, which increased the fire hazard.

Socio-Psychological and Administrative Root Causes of Arson

The key socio-disciplinary indicators are shown in Table 8. Almost all principals (75.3%) and students (76.5%) recognized the existence of student gangs. The majority of students (89.6%) reported that the conflict resolution strategy used was punitive (suspension or corporal punishment). 60.1% of students felt that guidance and counselling was not available or effective while 79.5% of principals felt that guidance and counselling was professional and available. The chi-square test verified that there was a significant association between the respondent group and perception of counselling availability, $\chi^2(2, N = 548) = 108.2$, $p < .001$. This difference was also significant, with 65.8% of principals reporting abusive language by teachers, 48.8% of teachers reporting abusive language by teachers and 94.0% of students reporting abusive language by teachers, $\chi^2(2, N = 548) = 145.9$, $p < .001$.

Table 8 Socio-Disciplinary Indicators Across Respondent Groups

Indicator	Principals	Teachers	Students
Presence of student gangs	75.3%	53.6%	76.5%
Punitive discipline dominant	79.5%	78.7%	89.6%
Counselling unavailable/ineffective	20.5%	21.7%	60.1%
Abusive language by teachers occurs	65.8%	48.8%	94.0%

Note. For counselling availability, $\chi^2(2, N = 548) = 108.2$, $p < .001$. For abusive language, $\chi^2(2, N = 548) = 145.9$, $p < .001$. Gangs and punitive discipline are merely descriptive.

Additionally, student governance structures were a source of tension. Democratic election of prefects was not used at all: 81.3% of students said that prefects were nominated by their teachers on merit. Furthermore, 60.5% of students indicated that they did not report incidents of abusive treatment, and administration did not follow up on their complaints.

DISCUSSION

The results of this study reveal a widespread and multi-faceted neglect of fire safety policy implementation in public boarding schools in Machakos County. There is a troubling disconnect between principals' positive self-perceptions and teachers' and students' perceptions of their experiences. 64.2% of students were completely unaware of any evacuation plan, and only 1.4% of principals noted that there was no plan. This could be a significant lack of communication, or it could be due to social desirability bias in administrative responses. Ondieki and Nyaboga (2022) also found that, in Kenyan schools, FEEPs are mostly implemented for administrative convenience without necessarily being ready to work.

The finding that there was very little practical training matches the study conducted by Mutua (2022) and Mutiso (2023) on sub-county level. If 90.3% of students can't use a fire extinguisher, in a fire emergency, installed fire extinguishers are useless. This is in direct violation of Maslow's belief that basic safety has to be guaranteed before learning can take place (Njoroge & Wambui, 2022). The use of standard bells, rather than fire alarms, also means that in a night-time fire, when perception is at its lowest ebb, the alarm time is prolonged.

The equipment and infrastructure gaps are nearly the same as those outlined in Mutunga and Mulei (2024) in the Auditor-General's assessments. The lack of smoke detectors and hydrants is especially worrying in the ASAL areas of Machakos, where water pressure is often weak, despite the presence of boreholes (Wambua & Muthama 2024). Continuous external locking of dormitories, as seen in 43.8% of schools, is repetitive of the conditions that led to the tragedy in Kyanguli. The persistence of that practice in spite of explicit instruction to the contrary is a sign of an administrative priority placing students' control over their own safety first rather than student safety.

The psychosocial findings provide an intriguing account of the arson aspect. According to Erikson's theory, as explained by Njoroge and Wambui (2022), adolescents need validating environments and legitimate avenues for grievances to be addressed to achieve successful identity formation. However, this study revealed a punitive disciplinary climate, taunts, and exclusionary prefect systems in school. 60.1% of students reported that there was no professional counselling available, as this is the main institutional response to psychological distress and substance abuse, leaving vulnerable students to seek resolution through collective violence. Kisilu and Mwende (2023) directly attributed the conditions to adolescent role confusion and arson.

There are significant differences between principals' claims and what is observed in the school, especially with regards to window grilles, and door swing, which suggests that principals may be giving socially desirable answers, making internal oversight difficult. This is in support of the recommendation made by Kamau and Wanjiru (2023) for the external inspections by Quality Assurance and Standards Officers (QASOs) which are unannounced to the school.

CONCLUSIONS AND RECOMMENDATIONS

The findings of this study support the conclusion that the preparedness for fire disaster in public boarding secondary schools in Machakos County is very critical. The risk exposure of learners occurs through nonfunctional evacuation programmes, lack of practical training, lack of adequate and well-maintained equipment, unsafe buildings and an attitude of punishment in the school which hinders the needs for psychosocial needs. Tragedy could be a structural option in Kyanguli.

In light of these findings, the following recommendations are made:

1. Cost neutral architectural corrections: school boards are required to immediately remove window grilles from ALL dormitories, refit exit doors to open outwards and prohibit external locking of exit doors during night-time.
2. Compulsory practical drills: Fire drills should be held termly and be recorded and verified by the QASOs, all staff and students should be trained in the use of extinguishers.
3. Invest in detection systems: All dormitory buildings should be equipped with battery-operated smoke detectors and manual sirens and these investments should receive a higher priority in capitation grants.
4. Professional counselling services: At least one registered counsellor will be employed in every boarding school, with the current situation where untrained teachers are given guidance roles replaced.

5. Democratic governance: The elections for prefects should be open and transparent, and regular open forums with students to provide safe grievance mechanisms should be instituted.
6. Improved inspection and accountability: Conduct unannounced QASO inspections - severe sanctions for principals who fail to comply, including those who lock dormitory doors.

Some limitations of this study are that it was a self-report, thus including social desirability bias especially from principals. Longitudinal observation and the connection of preparedness indices with actual fire incidents should be included in future research. Case studies of student arsonists would add to the understanding of the identified social and psychosocial pathways here.

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